CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Notes from 2019 Title 24 Part 6 Code Development Cycle Utility-Sponsored Stakeholder Meeting for Nonresidential HVAC

Meeting Information

Meeting Date: September 26, 2016

Meeting Time: 10:00 AM – 4:00 PM

Meeting Host: California Statewide Utility Codes and Standards Team

Attendees

First Name	Last Name	Contact	Organization
Statewide Utility Codes and Standards Team			
Utility Staff			
Jim	Kemper	James.Kemper@ladwp.com	Los Angeles Water Department of Water and Power (LADWP)
Marshall	Hunt	mbh9@pge.com	Pacific Gas and Electric Company (PG&E)
John	Barbour	JBarbour@semprautilities.com	San Diego Gas and Electric Company (SDG&E)
Chris	Kuch	Christopher.Kuch@sce.com	Southern California Edison (SCE)
Randall	Higa	Randall.higa@sce.com	Southern California Edison (SCE)
Bach	Tsan	Bach.Tsan@SCE.com	Southern California Edison (SCE)
Daniela	Garcia	DGarcia3@semprautilities.com	Southern California Gas (SoCalGas)
Christopher	Goff	CGoff@semprautilities.com	Southern California Gas (SoCalGas)
Raad	Bashar	rbashar@semprautilities.com	Southern California Gas (SoCalGas)
Codes and Standards Enhancement (CASE) Team Members			
Heidi	Hauenstein	hhauenstein@energy-solution.com	Energy Solutions
Erin	Linney	elinney@energy-solution.com	Energy Solutions
Vanessa	Morelan	vmorelan@energy-solution.com	Energy Solutions
Anna	Brannon	abrannon@integralgroup.com	Integral Group
Matt	Dehghani	mdehghani@integralgroup.com	Integral Group
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Ken	Takahashi	ktakahashi@integralgroup.com	Integral Group
Hillary	Weitze	hweitze@integralgroup.com	Integral Group
Farhad	Farahmand	FFarahmand@trcsolutions.com	TRC
California Energy Commission Participants			
Mark	Alatorre	mark.alatorre@energy.ca.gov	California Energy Commission (CEC)
Payam	Bozorgchami	payam.bozorgchami@energy.ca.gov	California Energy Commission (CEC)
Christopher	Meyer	Christopher.Meyer@energy.ca.gov	California Energy Commission (CEC)
Mazi	Shirakh	mshirakh@energy.ca.gov	California Energy Commission (CEC)
Peter	Strait	pstrait.energy.ca.gov	California Energy Commission (CEC)
Other Participants			
Mike	Schell		AirTest Technologies, Inc.
Frank	Morrison		Baltimore Airflow Company
Chris	Bradt		Bay Area Regional Energy Network (BayREN)

Darryl	DeAngelis		Belimo
Russ	King		Benningfield Group, Inc.
Bob	Raymer		California Building Industry Association (CBIA)
Skip	Ernst		Daikin
Janet	Peterson		EconomizerPro
Armin	Hauer		EBM-Papst
Jim	Hanna		Energy Solutions
Chandra	Gollapudi		Emerson Climate Technologies
George	Nebsitt		Environmental Design/Build
Tom	Meyer		ESCO Group
Mike	Wolf		Greenheck
Aniruddh	Roy		Goodman Manufacturing Company, L.P.
Bill	Bray		Honeywell
Adrienne	Thomle		Honeywell
Vincent	Lee		Mitsubishi Electric
Bo	White		Negawatt Consulting, Inc.
Davor	Novosel		National Energy Management Institute
Mark	Lyles		New Buildings Institute
Roger	Hedrick		NORESCO
Kyra	Weinkle		NORESCO
Robert	Davis		Pacific Gas and Electric Company
Mangesh	Ingle		Rheem Manufacturing
Manny	Windmiller		San Diego Gas and Electric Company
Sean	Gouw		Southern California Edison
Paul	Lindahl		SPX Cooling Technologies
Jeff	Stein		Taylor Engineering
Beth	Braddy		Trane
Theresa	Pistochini		UC Davis

Meeting Agenda

Time	Topic	Presenter
10:00 – 10:30	Introduction	Marshall Hunt (PG&E)
10:30 – 10:45	Compliance Improvement	Marshall Hunt (PG&E)
10:45 – 12:00	Fault Detection & Diagnostic (FDD) for Built Up Systems	Farhad Faramand (TRC Energy Services)
12:00 – 1:00	Lunch Break	
1:00 – 1:30	Cooling Tower Efficiency	Stefan Gracik (Integral Group)
1:30 – 2:15	Proposals Based on ASHRAE 90.1-2016: 1. Waterside Economizers	Stefan Gracik (Integral Group)
2:15 – 2:45	Break	
2:45 – 3:45	Proposals Based on ASHRAE 90.1-2016: 2. Exhaust Air Heat Recovery 3. Fan System Power	Ken Takahashi and Anna Brannon (Integral Group)

	4. Equipment Efficiency	
3:45 - 4:00	Wrap-up and next steps	Marshall Hunt (PG&E)

Key Takeaways and Action Items

1. Overview
    a. No key takeaways or action items.
2. Fault Detection & Diagnostic (FDD) for Built Up Systems
    a. Action item: Utility CASE Team will follow up with Janet Peterson to collect report that was developed in collaboration with WCEC on common economizer faults.
    b. Action item: Utility CASE Team will reach out to Janet Peterson to get information on study in SMUD territory that found systems were in DCV mode often.
3. Cooling Tower Efficiency
    a. Action item: Utility CASE Team will review comments submitted by the cooling tower industry to the ASHRAE mechanical sub-committee on the proposed revisions to the 2013 ASHRAE 90.1 requirements.
    b. Action item: Utility CASE Team will include architectural and structural impacts of using larger cooling towers CASE analysis.
    c. Action item: Utility CASE Team will review a small sample of the types of towers that could be eliminated from the market if the cooling tower efficiency measure were adopted.
4. Proposals Based on ASHRAE 90.1-2016: Waterside Economizers
    a. Action item: Utility CASE Team will review current market to identify products that could meet the increased wetbulb requirement for full waterside economizing.
    b. Action item: Utility CASE Team will review cost impacts of requiring a heat exchanger with a greater UA
5. Proposals Based on ASHRAE 90.1-2016: Exhaust Air Heat Recovery
    a. Action item: Utility CASE Team will review the proposed effectiveness for heat exchanger heat recovery and evaluate if it could be higher than 50%.
    b. Action item: Utility CASE Team will review cost impacts of co-locating intake and exhaust.
6. Proposals Based on ASHRAE 90.1-2016: Fan System Power
    a. Action item: Utility CASE Team will sample projects to determine typical fan system power in W/cfm.
    b. Action item: Utility CASE Team will look into the fan power adjustment factor table in ASHRAE 90.1 and evaluate which requirements need to be eliminated or revised.
7. Proposals Based on ASHRAE 90.1-2016: Equipment Efficiency
    a. No key takeaways or action items.

Meeting Notes

Overview of 2019 Title 24 Development

- Marshall Hunt (PG&E) presented on behalf of the Statewide Utility Codes and Standards Team.
- Presentation available here.

Comments and Feedback

1. Bob Raymer (CBIA): I was not aware that states needed to keep up with the International Energy Conservation Code (IECC) for residential buildings. Where in statute is Title 24 supposed to be equal to or better than IECC?
    a. Jon McHugh (McHugh Energy): This is part of the federal code. Compliance is a multi-step process. DOE first verifies that the newly adopted version of IECC or ASHRAE 90.1 is more stringent then than the previous version. DOE then requests that states submit documentation to certify the state building codes (residential and nonresidential) are at least as stringent as the latest version of IECC or ASHRAE 90.1
    b. Bob: Do they specify a particular edition of IECC?
    c. Mark Alatorre (CEC): DOE currently requires state codes to be at least as stringent as the 2015 IECC. The Energy Commission is in the process of verifying that the 2016 Title 24 Standards are as stringent as the 2015 IECC. CEC must submit information to DOE by June 2017.
    d. Marshall Hunt (PG&E): We will be make sure this is explained on Title24stakeholders.com.
        i. Follow-up from Utility CASE Team: This page on DOE's website explains states' requirements to establish building codes that are at least as stringent as model codes. Note, the website has a tab for both residential and nonresidential building codes.

Fault Detection & Diagnostic (FDD) for Built Up Systems

- Farhad Farahmand (TRC, Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. Aniruddh Roy (Goodman Manufacturing Company): By built-up do you mean air handlers?
    a. Farhad Farahmand (Utility CASE Team): Yes.
2. Jon McHugh (McHugh Energy): Unless the economizer is closed, the building managers does not know if there is a problem? Is that right?
    a. Janet Peterson (EconomizerPro): My company instruments roof top units, with a focus on economizers. We worked with Western Cooling Efficiency Center (WCEC) to try to figure out what was going on with economizers. Was it a failure problem or a maintenance issue? I can't tell you how many economizers were wired shut. Managers get a comfort complaint in the building at 3PM in the afternoon. The maintenance technician shows up at 9AM the next day and doesn't know what was going the previous day. They do something that will address issues so they can move on to the next job – they wire the economizer shut. The problem is often the timing of a fault being triggered and the maintenance staff arriving to address the fault, not a problem with the equipment itself. There is a report on this study. The idea is quick instrumentation and what could have been the value proposition or the cost of doing nothing to actually bring the economizer online from an energy savings and capital equipment point of view.
    b. Action item: Utility CASE Team will follow up with Janet Peterson to collect report that was developed in collaboration with WCEC on common economizer faults.
3. George Nesbitt (Environmental Design/Build): Why do FDD requirement only apply for systems over 4.5 tons?

   a. Farhad Farahmand (Utility CASE Team): Smaller systems typically do not come supplied with air-side economizers. Code is trying to address systems that typically have economizers.
      i. Adrienne Thomle (Honeywell): The reason that manufacturers don't like to ship anything less than 4.5 tons is that they don't know if it is going on a residential or commercial building.

4. Jon McHugh (McHugh Energy): If someone has an algorithm that says it will wait 24 hours before it throws a fault, is a system going to fail the acceptance test?
   a. Peter Strait (CEC): It will come down to how we specify the acceptance test. We will have to pay close attention to what we require in the acceptance test. When developing standards, we want to establish requirements that do not preclude particular systems.
   b. Mark Alatorre (CEC): The current test does have time limitations; we can see if the test needs to be revisited.
   c. Farhad Farahmand (Utility CASE Team): We have spoken to product vendors about this issue, and they do not usually have a lab to test the air-handler. Certification is also an item we might want to change.
   d. Adrienne Thomle (Honeywell): Think about the 24-hour time delay practically. If it is part of the energy system and you wait 24 hours, at least you only have 24 hours of it failing. Today, you have years of failure that go unnoticed. Once it throws a fault, it should keep the fault until it has been resolved.
      i. Farhad Farahmand (Utility CASE Team): The acceptance test technician may not be at the location two days in a row, so the fault may need to occur right when the technician is doing the test.
   e. Mark Alatorre (CEC): A potential alternative is thinking about applying the approach we currently use for economizers to FDD. That is, FDD system would be pre-certified to the CEC. The acceptance test would have two parts – a field inspection and a functional test. For the field inspection, they could verify that the FDD equipment is on CEC list of certified products. The functional test could be that the controller making communication with all required sensors. If we do that, we're assuming the certification is doing what it's supposed to do and that the sensor is functioning properly.
   f. Peter Strait (CEC): We don't want to preclude an approach for FDD.
5. Matt Dehghani (Utility CASE Team): One of our key assumptions is that there is very little additional cost to adding FDD to built-up systems. If anybody in the room or on the call can verify this, that would be incredibly helpful.
   a. Beth Braddy (Trane): The main cost is the upfront cost develop the software. There aren't any additional hardware costs, particularly if you are already doing this somewhere else in your system (e.g., in your DDC system). Developing the software is not an insignificant cost.
   b. Jeff Stein (Taylor Engineering): It looked like you were modeling your requirements after the ASHRAE Guide 36 requirements. We have been pretty involved in developing that standard. The hope with that standard is that vendors develop the FDD requirements as standard offerings. Since compliance with ASHRAE Guideline 36 will be standard practice, then the cost will be minimal.
   c. Farhad Farahmand (Utility CASE Team): My understanding is that ASHRAE Guideline 36 includes requirements for FDD, but they are not identical to the Title 24 requirements.
      i. Jeff Stein (Taylor Engineering): We don't want to reinvent the wheel or have multiple versions of FDD requirements. The Guideline 36 requirements are under

development now. If you have suggestions on ways to improve the requirements in Guideline 36, I encourage you to get involved in the process.

6. Jon McHugh (McHugh Energy): Pete Jacobs, with Architectural Energy, did a PIER Study on RTUs that are under 4 years hold and found a 45% failure rate. When you mention air care plus, is that only RTUs or are they doing built-up systems?
    a. Farhad Farahmand (Utility CASE Team): I'm not sure.
    b. Jon McHugh (McHugh Energy): There are some systems that already have FDD systems – some of which are working properly. We don't need to capture savings from the systems in which the FDD system is working correctly. What is the average for the systems that do not have algorithms that are throwing faults currently? What fraction of systems already have FDD? What are the best estimates of failures in the remaining group?
    c. Farhad Farahmand (Utility CASE Team): If anyone has any data, we would appreciate it.
7. Farhad Farahmand (Utility CASE Team): Are there market actors or resources that we have not identified?
    a. Daryl DeAngelis (Belimo): Controls contractors should be included.
    b. Janet Peterson (EconomizerPro): We are not seeing the sustainability of the system and equipment through maintenance and repairs. The follow-up to Title 24 compliance, which is the maintenance and repair, is important and needs to be continual for long-term sustainability. For example, somebody purchased a replacement filter and accidentally left the plastic on the filter. It went for two years without being noticed.
        i. Jon McHugh (McHugh Energy): Would the proposed FDD requirements have captured the problem cause by plastic on the filter?
        ii. Farhad Farahmand (Utility CASE Team): Possibly.
    c. Matt Dehghani (Utility CASE Team): As a designer, we use Energy Code Ace. It is a very helpful tool.
    d. Chris Bradt (BayREN): I have an observation about the market actors. Acceptance Test Technicians (ATTs) do not have to complete test on mechanical systems. Until ATTs are required to complete mechanical acceptance tests, I'm not sure how much feedback you will get from them. The ATTs are not working in every jurisdiction throughout the state.
        i. Peter Strait (CEC): You're right. The Acceptance Test Technician requirements were adopted with the understanding that we could require the technician to complete a wide variety of tests. Right now mechanical tests do not need to be completed by an ATT. Although the ATT network is not fully functional now, we do want to make sure we are drafting requirements that will make sense when it is the case that an ATT is require to conduct the mechanical testing.
        ii. Chris Bradt (BayREN): You could outreach to Acceptance Test Technicians and other third party verifiers to get t to get their view.
        iii. Jon McHugh (McHugh Energy): What are the current requirements for Acceptance Test Technicians and acceptance tests, and what is currently triggered?
            1. Mark Alatorre (CEC): The acceptance test is required for Title 24 compliance, but it does not need to be completed by a certified Acceptance Test Technician to perform the test.
            2. Tom Meyer (ESCO Group): Lighting acceptance tests must be completed by a certified Acceptance Test Technician who are trained and

certified by Acceptance Test Technician Certification Providers (ATTCPs). Mechanical side has four ATTCPs that are accredited by the Commission, but until the Commissioners feel an acceptable threshold of technicians and distribution is met, mechanical tests do not need to be completed by an ATTs.

8. Daryl DeAngelis (Belimo): Is the intent for the requirement to cover hydronic systems (DX)?
    a. Farhad Farahmand (Utility CASE Team): Yes, it would cover chilled water systems with an air-side economizer.
    b. Aniruddh Roy (Goodman Manufacturing Company): Is it possible to have a definition section to describe all units that are covered this requirement?
        i. Mark Alatorre (CEC): Yes, that is a possibility.
9. Farhad Farahmand (Utility CASE Team): I have a question for Beth Braddy – Would it be okay with the packaged unit manufactures if they have to show some type of functional testing whereas the built-up DDC systems would not have to show functional testing?
    a. Beth Braddy (Trane): For the packaged equipment, there is an existing Title 24 requirement that allows manufacturers to pre-certify FDD controls that are installed with equipment that we sell. If there is an ability to pre-certify for built-up systems, we would likely follow that same compliance process for built-up systems. Pre-certification is an easier compliance pathway than completing using an acceptance test. We would rather have a pre-certification than having to do a full acceptance test each time.
    b. Jon McHugh (McHugh Energy): Beth mentioned that pre-certification is preferred, but I see value in at least some version of a field verification to make sure the system is installed correctly? Perhaps there could be a less rigorous on-site certification if the equipment is pre-certified? Beth, would this capture your concern that not every system would have to conduct a full acceptance test, but there would still be a field verification step to ensure equipment was installed correctly?
    c. Beth Braddy (Trane): I think that would be a good compromise. When equipment is not pre-certified a lot of documentation is required for the acceptance test. Unless the equipment is per-certified, somebody has to collect whole lot of technical specifications about the system. I like the idea of the available documentation for pre-certified equipment to be available on CEC's website. The person who completes the acceptance test can simply point to the documentation that is already on the CEC's website as opposed to having to collect the documentation from many sources.
    d. Jon McHugh (McHugh Energy): Are you talking about a database of pre-qualified sensors?
    e. Beth Braddy (Trane): Not necessarily, although we could go that route. My understanding is that when you pre-certify FDD, manufacturers submit information about the system and a declaration of compliance to CEC. CEC approves systems that meet the requirements. Once approved, systems are listed in the database as meeting all the mechanical specifications. Pre-certification means the product meets all the specifications with the data package. The "does it work" part would be verified in the field. It is a package solution that is certified as a whole, and as a FDD manufacture, you are certified to provide that solution on-site.
    f. Peter Strait (CEC): That is generally how that works in a high-level view. When CEC certifies FDD, we are certifying that the whole system works, we do not certify subcomponents of system. We are certifying that when an FDD system is installed and configured properly is it actually communicating to all sensors that it needs to in order to

perform as required. How this translates to on-site field testing, we are going to take a nuanced approach to this. At a minimum, is it actually communicating to all of its sensors. Ideally, it could be a tool for the acceptance test technician, if it reports a fault, it prompts them to go in and fix the fault when an FDD is installed.

10. Farhad Farahmand (Utility CASE Team): What are peoples' experiences with economizer FDD in built-up system?
    a. Peter Strait (CEC): People are welcome to send information after this meeting. This is an open opportunity to send us any information you have.
    b. Beth Braddy (Trane): Unless something changes significantly with the FDD requirements, our intention is use the same algorithm we have already developed for packaged systems for built-up systems. We use the same or similar components with an air-side economizer so the same logic would apply from what we have been able to determine.
11. Peter Strait (CEC): Are people seeing tablet- or smart phone- platforms for thermostat or indicator displays becoming more common? Do you anticipate a shift towards tablet displays for FDD or will the interface remain somewhat old-school?
    a. Beth Braddy (Trane): Package DX, smaller light commercial unitary systems are not DDC controlled system. With 2016 version of Title 24, there were new provisions that required faults to be annunciated in the space or at the zone thermostat. This makes sense as you do not have to go to the roof to see if there is a problem. It is being annunciated locally. We have reached out to thermostat manufactures. They are moving towards having displays on a local level, sometimes even touchscreen displays. We expect that the market will continue to go in this direction as consumers desire a way to interact with their building systems.
12. Randall Higa (SCE): One of the differences I see in packaged versus built-up systems is package units don't typically have power exhaust or return fans whereas built-up systems do because of the larger air quantities. Smaller units probably only have a barometric relief. For built-up systems there is usually return air and exhaust. Does this warrant special consideration? The economizer usually does more than just economizing – they enable demand control ventilation and morning warm-up.
    a. Beth Braddy (Trane): For package units, there is not an upper limit for FDD. It starts at 54,000 Btu/h and goes upward. Larger DX package systems do include power exhaust and other features that you typically see in built-up systems. Those systems tend to be DDC controlled systems verses the thermostat, light commercial type of installation, but we have implemented FDD on both systems. We had to navigate separating the control of the economizer and the economizer's performance to meet the code verses how the DDC controller manages other parts of the system. There is a lot of similarity between large DX systems to built-up air handling systems verses high volume light unitary equipment.
    b. For package DX implementation, there
    c. Janet Peterson (EconomizerPro): We did some instrumentation on systems in SMUD territory. The system was in DCV mode a lot. So considering the impacts of DCV is very important.
        i. Action item: Utility CASE Team will reach out to Janet Peterson to get information on study in SMUD territory that found systems were in DCV mode often.

Cooling Towers Minimum Efficiency

- Stefan Gracik (Integral Group, Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. Marshall Hunt (PG&E): Cooling towers are made up of lots of parts. Which parts of the cooling tower is this measure applicable? Does it touch the fan power, the pumps?
    a. Stefan Gracik (Utility CASE Team): This measure just addresses fan power. It does not address the pumps.
    b. Marshall Hunt (PG&E): why is there a gallons per minute classification?
        i. Stefan Gracik (Utility CASE Team): Title 24 rates the size of cooling towers in GPM/HP with HP meaning fan horse power.
        ii. Jon: Is this how the Cooling Tower Institute (CTI) rates cooling towers?
        iii. Mark Alatorre (CEC): Yes. This is the metric that CTI uses to rate cooling towers.
2. Frank Morrison (Baltimore Aircoil Company): Is the GPM/HP a nominal fixed condition of 95-85-75. The ASHRAE 90.1-2016 requirement is 40.2 GPM/HP. Check the comments submitted by the cooling tower industry to the ASHRAE mechanical sub-committee on the proposed revisions to the 2013 ASHRAE 90.1 requirements. A level of 80 GPM/HP removes a significant portion of models from the market, which reduces the freedom of the designer to apply water-cooled systems that are already the most efficient system on the market.
    a. Stefan Gracik (Utility CASE Team): Yes, the GPM/HP is based on a nominal fixed condition of 95°F entering water, 85°F leaving water, and 75°F entering air wet bulb based on Table 110.2-G in Title 24 Part 6. This measure goes beyond ASHRAE 90.1. We will review the comments.
    b. Mark Alatorre (CEC): The current (2016) Title 24 requirement is 42.1 GPM/HP, which was modeled after ASHRAE 90.1-2013.
    c. Peter Strait (CEC): Frank, from a manufacture perspective, is there a specific technology solution or technique that is necessary to achieve higher efficiency? Is the lack of models that would meet the proposed requirement due to a technical challenge?
        i. Frank Morrison (Baltimore Airflow Company): The industry produces box sizes that can be shipped on trucks and installed in buildings. The units vary in size. The models in the lower HP range use less energy. You oversize the tower to get a lower GPM/HP. There are significantly fewer models available in the 80 GPM/HP.
        ii. Matt Dehghani (Utility CASE Team): In California market, we are seeing a trend towards higher efficiency cooling towers. Is that observation inconsistent with yours?
            1. Frank Morrison (Baltimore Airflow Company): We certainly encourage higher efficiency towers, but we are also concerned that people will use other types of systems that are less efficient because the higher efficiency systems are more expensive for the consumer.
    d. Jon McHugh (McHugh Energy): ASHRAE 90.1 does not have a requirement that water-cooled equipment must be used if the systems are over a given size threshold. Title 24 does require systems of some size to use water-cooled equipment. Does the fact that Title 24 requires water-cooled systems address the concerns that requiring higher efficiency

equipment will lead to people using the wrong type of system – an issues that was raised in discussions about changing the ASHRAE requirements for the 2016 cycle?

i. Frank Morrison (Baltimore Airflow Company): It certainly helps by limiting market impact. You are right that Title 24 requires water-cooled equipment and that requirement does help alleviate concerns. In 2013, the industry worked with CEC to agree on a higher value than ASHRAE 90.1 because of the 300-ton limit on air-cooled chillers.

ii. Frank Morrison (Baltimore Airflow Company): We would like to work with the Energy Commission on this requirement. We also recommend working with ASHRAE Technical Committee 8.6, which is the ASHRAE technical committee on cooling towers and evaporative condensers, and the Cooling Tower Institute. Both ASHRAE TC 8.6 and CTI have interest in making sure the overall efficiency of the market is protected.

iii. Stefan Gracik (Utility CASE Team): We are working on how to address concerns that the larger towers with higher GPM/HP requirements take up more space.

iv. Frank Morrison (Baltimore Airflow Company): The industry is concerned with the limited amount of space available for heat rejection. There may be cases where you could not use water cooled equipment.

v. Stefan Gracik (Utility CASE Team): We are proposing the cooling tower requirements as prescriptive requirement. If builders do not want to meet the prescriptive GPM/HP requirement, they could use the performance approach and use other measures to make up the savings.

e. Action item: Utility CASE Team will review comments submitted by the cooling tower industry to the ASHRAE mechanical sub-committee on the proposed revisions to the 2013 ASHRAE 90.1 requirements.

3. Jeff Stein (Taylor Engineering): Have you included any of the cost associated with architectural or structural impacts of using larger towers?
   a. Stefan Gracik (Utility CASE Team): We have not included these costs yet, but we are thinking about it.
   b. Action item: Utility CASE Team will include architectural and structural impacts of using larger cooling towers CASE analysis.
4. Paul Lindahl (SPX Cooling Technologies): SPX makes cooling towers. The thing that is confusing is that the reality of cooling tower applications is they come in a wide variety of shapes and sizes. When you are talking about size limitations, you might have limitations on height, width, or length. We have diverse product offerings to meet a variety of design constraints like external pressure and sound limits. More likely you will change the height than the fan diameter.
   a. Marshall Hunt (PG&E): This is a prescriptive measure. It might be helpful to know how much energy the cooling towers uses relative to the entire building. Integral Group could look at this.
   b. Frank Morrison (Baltimore Airflow Company): Cooling towers may only account for 6% of the total system energy use. There may be larger savings from the chiller. We don't want systems to move to less efficient alternatives. If you look at the 2013 CASE Report for cooling towers, you will see those comments.
      i. Stefan Gracik (Utility CASE Team): Larger towers tend to have larger approaches, at least for water-side systems

ii. Frank Morrison (Baltimore Airflow Company): Larger towers don't have different approaches. Regardless of the tower size, the thermal duty is the same. There is no impact on the approach.

5. Peter Strait (CEC): Why did ASHRAE 90.1 settle on 40.2 GPM/HP? Was it driven by a specific challenge or breaking point?
    a. Paul Lindahl (SPX Cooling Technologies): 40.2 GMP/HP has been in place in ASHRAE 90.1 for a while. 42.1 GMP/HP was an increase over the ASHRAE baseline, which is lower. For Title 24, the stakeholder groups negotiated to come up with value. It was a willingness to accommodate the need for higher efficiency recognizing the threat for the application of cooling towers to be switched to air-cooled technologies that were lower than the 300-ton limit.
6. Jeff Stein (Taylor Engineering): This will only impact a small portion of cooling towers. It is a prescriptive measure, and builders can do other things to make up for the savings from the more efficient tower. The baseline for the performance approach is water-cooled chiller and there is no trade-off. The performance approach uses 60 GPM/HP as the baseline. Were you intending on changing the baseline for the performance approach?
    a. Stefan Gracik (Utility CASE Team): Yes. We plan on updating the performance baseline to match the prescriptive requirement, which would modify the performance assumption to 80 GPM/HP. For our analysis we used the baseline of 42.1 GPM/HP because that is the current prescriptive baseline.
7. Stefan Gracik (Utility CASE Team): Are we missing and market actors?
    a. Marshall Hunt (PG&E): Add structural engineer.
    b. Marshall Hunt (PG&E): This is not an appliance standard, there is interaction between the performance modeler, the manufacture, and building designers, so this could be an iterative process. Would be helpful to add a note that there is an option to make up the savings elsewhere?
8. Frank Morrison (Baltimore Airflow Company): Is there any other class of HVAC equipment that is being looked at in terms of efficiency requirements, particular of this magnitude?
    a. Peter Strait (CEC): A majority of heating and cooling equipment is federally regulated, and states are preempted from adopting their own stands. Cooling tower efficiency does not have preemption issues, which is why the CASE Team is looking at efficiency requirements.
    b. Marshall Hunt (PG&E): In building standards, we think about the whole system. We do want to look at system efficiency – not just equipment efficiency.
9. Paul Lindahl (SPX Cooling Technologies): You are actually talking about eliminating as many as half of the models. Is that a reasonable change to make in one step? Somebody should look at the cooling towers that are available and what products would be eliminated if this standard is adopted.
    a. Peter Strait (CEC): The primary driver of model options is size limitations. This measure would require larger towers. Are you saying that the smaller models would not meet this efficiency level?
    b. Paul Lindahl (SPX Cooling Technologies): It would eliminate the highest capacity model for each box. It is difficult to describe without looking at the impact on power selections by eliminating all that are 80 GPM/HP or greater. I suggest you look at the selection software and what the impact really is.
    c. Peter Strait (CEC): I agree, I think a description of what would be excluded and reasons why would be useful. Maybe your company can help us develop this.

d. Marshall Hunt (PG&E): I will ask Integral Group to look at that data and use it in some scenarios. Again, this is a prescriptive measure. The proposal would not prohibit the use of the towers that are available today. People can still use the less efficient tower, but make up the savings elsewhere in their building design – including the HVAC system or other building systems.
e. Action item: Utility CASE Team will review a small sample of the types of towers that could be eliminated from the market if the cooling tower efficiency measure were adopted.

Proposals Based on ASHRAE 90.1-2016: Waterside Economizers

- Stefan Gracik (Integral Group, Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. Beth Braddy (Trane): In ASHRAE 90.1 there is an exception to the water- and air-side economizer requirements. There is a table that presents EER and IEER efficiency levels for equipment. If the equipment meets the threshold limit, you are exempt from the economizer requirement. Is there a plan to include a similar exemption for Title 24?
    a. Mark Alatorre (CEC): Title 24 has exceptions for both air- and water-side economizers.
2. Skip Ernst (Daikin): Regarding the 45 to 49 degree change over: ASHRAE 90.1 says that the 45 degree wet bulb water economizer should satisfy the building load. If you raise it to 49 degrees will existing products be sufficient? Did you study the effect of whether existing products can actually do that? Can you tell us what the typical percent building load is so we can try to determine it ourselves?
    a. Stefan Gracik (Utility CASE Team): There are products that can meet this requirement. We will examine the market further to identify percentage of all products that could meet the requirement.
    b. Action item: Utility CASE Team will review current market to identify products that could meet the increased wetbulb requirement for full waterside economizing.
    b. Skip Ernst (Daikin): Floor-by-floor packages with water economizers would be impacted. Did you check if these products would be able to comply? These are typically found in four-story buildings and above.
    c. Stefan Gracik (Utility CASE Team): Equipment that is most affected by different wet bulb requirements would be the heat exchanger for the water-side economizer and the cooling tower selection.
    d. Skip Ernst (Daikin): The 45 verse 49 degree implications from ASHRAE 90.1 would determine what the water economizer cooling coil would have to be capable of doing. In the product I'm talking about, it is an actual pre-cooling coil in series with the DX coil.
    e. Stefan Gracik (Utility CASE Team): I see your point. You are concerned that if you raise the wet bulb temperature to 49 degrees, some products might not be capable of achieving the required cooling. We can look into the implications on a wider range of products.
    f. Marshall Hunt (PG&E): This is a prescriptive requirement, so you can make up the efficiency somewhere else.
3. Jon McHugh (McHugh Energy): Does this require a greater UA for the heat exchanger? What are the costs associated with the impacts to the heat exchanger?

   a. Stefan Gracik (Utility CASE Team): Yes, you will likely need a heat exchanger with a greater UA. There will likely be a cost, and we will look at this.
   b. Action item: Utility CASE Team will review cost impacts of requiring a heat exchanger with a greater UA
4. Stefan Gracik (Utility CASE Team): Is a two-degree approach too aggressive?
   a. Frank Morrison (Baltimore Airflow Company): Two degree may be a little aggressive. The heat exchangers are getting larger with the advent of AHRI certification. I suggest you look at both a 2 degree and 3 degree difference and look at the results. You need to look at the impact on approach. Make sure the heat exchangers you look at is AHRI 400 certified.

Proposals Based on ASHRAE 90.1-2016: Exhaust Air Heat Recovery

- Ken Takahashi (Integral Group, Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. Matt Dehghani (Utility CASE Team): Can you explain the assumed hours of operation?
   a. Ken Takahashi (Utility CASE Team): Heat recovery unit only operates when the economizer is off. That is, heat recovery ventilator will only be on when it is too hot or too cold for the economizer. There aren't too many hours of the year when heat recovery is on.
2. Marshall Hunt (PG&E): For the savings estimates, you set the efficiency at 50 percent. If somebody came in with a more efficient system would they get some compliance credit? Look into if 50 percent is reasonable. We should be establishing a requirement that encourages efficiency. We don't want the baseline efficiency to be too low.
   a. Ken Takahashi (Utility CASE Team): The assumptions is 50 percent sensible effectiveness looking at plate effectiveness. California is dry enough that we don't need an enthalpy wheels. There are issues with enthalpy wheels.
   b. Marshall Hunt (PG&E): 50 percent sensible only may be more reasonable. Again, can one get credit for more efficient systems if they use the performance approach, and is 50 percent too low for the baseline efficiency?
   c. Action item: Utility CASE Team will review the proposed effectiveness for heat exchanger heat recovery and evaluate if it could be higher than 50%.
3. Jeff Stein (Taylor Engineering): Heat recovery is prohibitively expensive because it would require the exhaust to be at the same location as the intake. We did lab studies for 2013 Title 24 Standards, and found heat recovery is more expensive because of bring the exhaust back to intake. It is often prohibitively expensive to co-locate intake and exhaust. In addition, the savings were lower than VAV in laboratories. I encourage you to look at the analysis and we can share with you. ASHRAE 90.1 analyses assumed bypass around, so the energy losses were minimal. Heat recovery increases energy use in most cases. You have to make up for the fan energy use. You can do this by installing a bypass – which also adds cost. If a building is only running at 10-20 percent outdoor air, you might not have any exhaust air left after exfiltration to keep building properly pressurized. Make sure you include losses for pressurization in your analysis.
   a. Matt Dehghani (Utility CASE Team): In your experience with bypass on heat recover element, does that have an associated fan energy savings? What I've seen in package units available with air-to-air heat recovery with a bypass, the opening for the bypass

tends to be small and has a smaller pressure drop than would be associated with the actual heat recovery element. So the bypass is intended to not pre-heat the incoming air more than to reduce fan energy loss. Has this been something you've experienced?

   b. Jeff Stein (Taylor Engineering): The bypass doesn't need to be full sized, you could size it however you want. If pressure drop is not negligible, you need to include it in your analysis.
   c. Matt Dehghani (Utility CASE Team): We were conservative in our analysis, assume no fan energy savings associated with the bypass.
   d. Action item: Utility CASE Team will review cost impacts of co-locating intake and exhaust.

4. Jeff Stein (Taylor Engineering): You mentioned pre-heating the outside air. A lot of systems do this to neutralize the air. You don't need to heat the air all the time just because it is a dedicated outdoor air system.
   a. Matt Dehghani (Utility CASE Team): In Ken's analysis, anytime that you are in a temperature band that would allow you to economize, it fully bypasses the heat recovery element. It is only heat recovering when the outdoor air is below the threshold of when you would prescriptively need to economize. Our analysis is conservative and there are many design options that could show more savings.

Proposals Based on ASHRAE 90.1-2016: Fan System Power

- Ken Takahashi (Integral Group, Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. Marshall Hunt (PG&E): The existing fan power requirements are prescriptive, so you could make up for it with other requirements
   a. Ken Takahashi (Utility CASE Team): Yes.
2. Marshall Hunt (PG&E): What is the standard MERV rating for filters? CARB is pushing for MERV 11 and up for residential. You should be looking at pressure drop on various MERV rating filters. We will be getting some guidance on MERV and pressured drop in residential buildings.
   a. Ken Takahashi (Utility CASE Team): The pressure drop through MERV 9 to 12 is 0.5 inch. MERV 9 to 13 is 0.9 inches. We can look into this.
3. Jeff Stein (Taylor Engineering): Have you completed a survey of buildings that this would impact. My experience is the ASHRAE requirement is so weak that most buildings would already comply, and we would not capture much energy savings. If we implement this measure, it will add a compliance step without the benefit of saving energy.
   a. Ken Takahashi (Utility CASE Team): Good suggestion. I have look at mechanical schedules from Integral Group's projects.
   b. Matt Dehghani (Utility CASE Team): One valuable aspect is we are targeting fans under 25HP, which were previously unregulated.
   c. Jeff (Taylor Engineering): This would apply to fans in package units that would have applied to the ASHRAE requirements anyways. What are we gaining apart from adding a calculation for compliance?
   d. Ken Takahashi (Utility CASE Team): In a few slides, I am going to present ideas on how we can go beyond ASHRAE 90.1 requirements to gain more savings.

   e. Action item: Utility CASE Team will review a sample of projects to determine typical fan system power in W/cfm.

4. Kyra Weinkle (NORESCO): Give that this is a new requirement for 2016, how does anyone in the audience anticipate this changing how you comply with code?
   a. Ken Takahashi (Utility CASE Team): People are already used to complying with the ASHRAE requirements. Most designers who work outside of California will be use to using this calculation method.
5. Jeff Stein (Taylor Engineering): I'm glad you are looking at the static pressure requirements used in the compliance software. It is a good opportunity to explore, but it might not be appropriate to apply these levels as prescriptive requirements. I suggest looking at the adjustment factor table in ASHRAE 90.1. Perhaps it makes sense to eliminate or revise some of the adjustment factors.
   a. Ken Takahashi (Utility CASE Team): Yes, we will adjust ASHRAE factors so that we will see energy savings.
   b. Jon McHugh (McHugh Energy): What Jeff is talking about is looking at cost-effectiveness and the appropriateness for a variety of designs. This is expected of all CASE Authors. Looking at these questions for fans is not a small task, but it is something that we need to do for the CASE Analysis.
   c. Action item: Utility CASE Team will look into the fan power adjustment factor table in ASHRAE 90.1 and evaluate which requirements need to be eliminated or revised.

Proposals Based on ASHRAE 90.1-2016: Equipment Efficiency

- Anna Brannon (Integral Group, Utility CASE Team) presented.
- Presentation available here.

Comments and Feedback

1. No comments or questions on this proposed code change.